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Original Article

Phytochemical Screening of Plants Used to Prevent COVID-19 in Fako Division South West Region, Cameroon

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ABSTRACT

The use of plants for different healthcare and other ethnobotanical purposes has been a common practice worldwide, Cameroon inclusive. With the emergence of COVID-19 human reliance on plants intensified. This work aimed to document and phytochemically screen plants used against COVID-19 in Fako Division, South West Region, Cameroon. This was achieved through semi-structured questionnaires and laboratory analysis. Indices such as frequency of citation (FC), use value (UV), relative frequency of citation (RFC), and fidelity level (FL) were employed to quantify the information. The documented plants were ranked and the top eight plants most frequently cited were screened phytochemically for alkaloids, flavonoids, cardiac glycosides, phenols, saponins, steroids, tannins, and terpenoids following standard procedure. A total of 43 plant species were recorded belonging to 29 families and 38 genera. Rutaceae and Asteraceae were the most used plant families with four species each. Leaves were the most frequently used plant part and herbs were the most common plant form. Cymbopogon citratus was the most cited species with a frequency of citation of 100. Curcuma longa had the highest use value (0.06), Cymbopogon citratus had the highest RFC (0.33) and Artemisia vulgaris had the highest FL (88.23%). Twenty-two plant-based recipes were recorded with recipe 9 (Decoction) being the most used. One hundred and two active compounds were detected from the eight screened

plants in different proportions and classes. Cymbopogon citratus had the largest number of active compounds (15) with steroids being the most represented phytochemical constituents. The screened plants can be exploited as potential sources of medication.
Keywords: Phytochemical screening, Plants, COVID-19, Fako Division-Cameroon.

INTRODUCTION

Coronavirus disease (COVID-19) is an infectious disease caused by a newly discovered severe acute respiratory syndrome coronavirus2 (SARS-CoV2). These viruses are infectious agents of the respiratory tract but can also affect the digestive tract and systemically infect both humans and animals (Malik *et al.*, 2020). They are single-stranded RNA viruses, which are highly diverse. The first case of COVID-19 was reported in Wuhan, China, on December 31, 2019, and sometime later, Thailand reported the first case of the disease outside of Mainland China on January 13, 2020 (Guan *et al*., 2020). Most people infected with the COVID-19 virus will experience mild to moderate respiratory illness and recover without requiring special treatment (Himmelfarb and Baptiste, 2020). Older people, and those with underlying medical problems like cardiovascular disease, diabetes, chronic respiratory disease, HIV, and cancer are more likely to develop serious illness (Care *et al*., 2020).

Although it is still unknown where the outbreak started, many early cases of COVID-19 have been attributed to people who visited the Huanan Seafood Wholesale Market, located in Wuhan, Hubei, China (Sun *et al*., 2020; Care *et al*., 2020). On 11 February 2020, the World Health Organization (WHO) named the disease "COVID-19", which is the short form of Coronavirus Disease 2019 (WHO, 2020). Spread of the virus is rapid. The first confirmed case of the virus in Cameroon was reported in March 6, 2020 and by April 25, the number had increased to 1569, with 53 deaths (Mbopi-Keou *et al*., 2020). Before that year elapsed, 10 out of the I8 Health Districts in the Southwest region of the country reported confirmed cases; 75% of the cases were recorded in Buea and Limbe Health Districts, 15% in the Kumba Health District (WHO, 2020) and the remaining 10% in the other districts.

When COVID-19 struck, public health experts predicted that it would be particularly devastating in Africa (Berhan, 2020; Bwire *et al*., 2022). A UN agency estimated that, in the worst-case scenario, 3.3 million Africans would die from the disease (Kalina *et al*., 2021). Contrary to this view the number of cases recorded in this region was lower than in any other region of the world. Although control of the infection lacks a specific vaccine or drugs, the high dependence of the African population on herbal medicine or plants related medicine to solve health ailments such as colds, coughs, and viral diseases is thought to have been the cause of these low incidences (Awono *et al*, 2016). In Cameroon and the Southwest region in particular, the advent of

COVID-19 triggered almost every household to deepen this dependence, with different plants used in different formulations. Indigenous knowledge has been a source of medicinal agents for thousands of years (Shah and Bhat, 2019).

Documentation on the use of plants against human health ailments and ethnobotany in general have been of global increasing concern. In Cameroon, Jiofack *et al.* (2008) investigated the ethnobotany and phytopharmacopoea of the South West and Littoral ethnoecological region of Cameroon in which they highlighted the use, commercialization, cultivation, and conservation status of the major medicinal plants within the South-West and Littoral ethnoecological regions of the country. Focho *et al.* (2009), worked on medicinal plants of Aguambu-Bamumbu in the Lebialem highlands, Southwest region of Cameroon in which they identified the different medicinal plants used in traditional pharmacopoeia for the treatment of diseases affecting the human body. Similarly, Simbo (2010) did an ethnobotanical survey of medicinal plants in Babungo, Northwest Region of the country while Ntie-Kang *et al.* (2013) documented Cameroonian medicinal plants, making bioactivity versus ethnobotanical survey and chemotaxonomic classification. From a very specific perspective, Ngono *et al.* (2011) did an ethnobotanical survey of some Cameroonian plants used for the treatment of viral diseases while Johnson and Fongnzossie (2020), surveyed ethnobotanically, plants used as amulets among the Banen ethnic group in Ndiki Sub-Division (Centre Region of Cameroon). The Ethnobotany of wild edible plants used by Baka people in southeastern Cameroon was surveyed and documented by Billong *et al.* (2020). Despite these efforts, little is documented regarding the use of plants against COVID-19. The few studies done in this respect include the works of Fokou and Fokouo (2020) which explored the indigenous knowledge systems responses to COVID-19 infection in Yaounde and Douala. In a similar light, review of medicinal plants with the potentials for the management of the COVID-19 pandemic and use as complementary therapies against the disease have been documented (Fongnzossie *et al.*, 2020; Fedoung *et al.*, 2021)). Though of great scientific contribution, the aforementioned studies were broad-based with no area specificities. Knowledge on the use of plants varies from place to place and spatial variations have been reported to impact the production and accumulation of secondary metabolites in plants (Gobbo-Neto *et al.*, 2017). This study therefore aimed at documenting plants used against COVID-19 in Fako Division, South West Region, Cameroon, and to evaluate the phytochemical characteristics of these plants.

Materials and Methods

Description of the study area

Fako Division (Fig 1) is situated in the South West Region of Cameroon and covers a total area of 2093 km^2. It is located between latitudes $4^0 0'$ to $4^0 20'$ and Longitude $9^0 0$ to $9^0 25$ (Ndemanou, 2017). The division is made up of six sub-divisions: Buea, Limbe I, Limbe II, Limbe III, Tiko, Muyuka, and the West Coast. As of the last population census, the division had a total population of 1, 515, 888 inhabitants (Institut National de la Statistique, 2015). Of the six divisions in the South West region, Fako is a cosmopolitan area with numerous urban and semi-urban towns (Kaldjob *et al*., 2019). The division belongs to a humid forest with monomodal rainfall and fertile soils which offer favorable conditions that are very supportive of vegetation and agriculture.

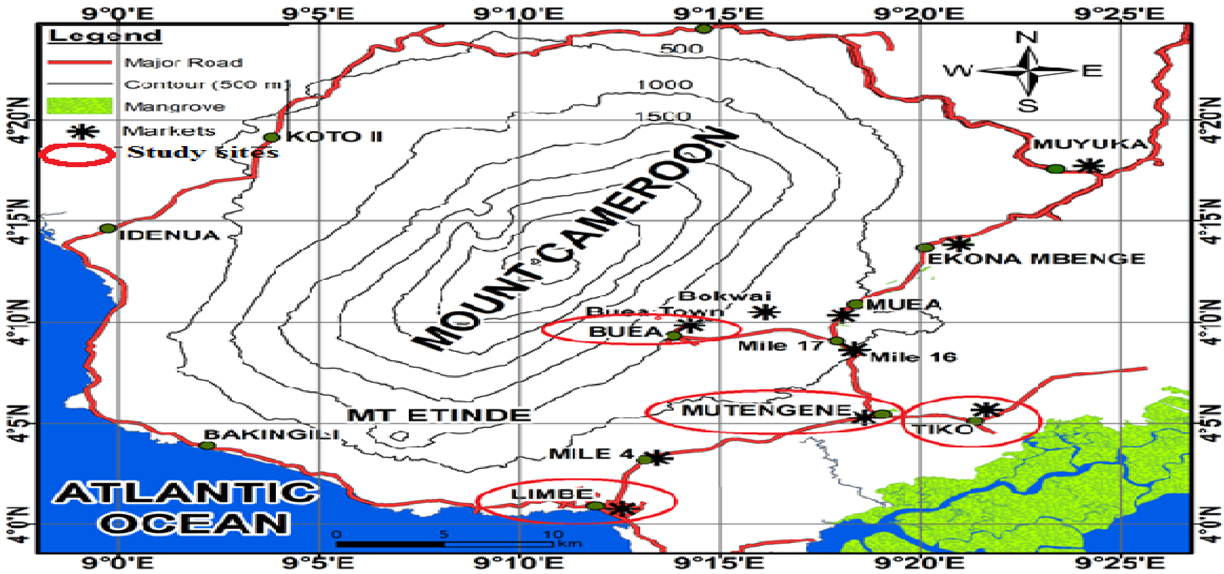

Figure 1: Location of the study area

Ethnobotany of Plants Used Against COVID-19 in Fako

Information on plants used against COVID-19 was collected from March 2022 to September 2022 in Fako division using methods adapted from Jovel *et al,* (1996) and Focho *et al*, (2009), consisting of interviews, open-ended and semi-structured questionnaires as well as the show and tell method. These were conducted on people in Buea, Limbe, Mutengene, and Tiko. The administration was random for both sexes from the age of 20 to >60. The interviews were conducted face-to-face with individual participants, as well as in group discussions. The questionnaire recorded data about, demography, plants used against covid-19 as well as other uses of these plants. The identified plants were classified according to APG III and grouped into different growth habits. The data collected were analyzed using various quantitative indices: Use Value (UV), Relative Frequency of Citation (RFC), Frequency of Citation (FC), and Fidelity Level (FL).

Use Value (UV)

Use Value (UV) shows the relative importance of plant species by considering a number of use reports mentioned by indigenous inhabitants of the study area. This was calculated according to Assefa *et al*. (2019):

$UV = UVi/Ni$

Where
'UVi'= frequency of citations for species through all respondents
'Ni'= number of respondents

Relative Frequency of Citation (RFC) and Frequency of Citation (FC)

Relative Frequency of Citation (RFC) was used to elucidate the agreement among the local informants about therapeutic medicinal flora which is consumed for the treatment of various diseases.

RFC= FC/N (Faruque *et al*., 2018)

Where FC (Frequency of Citation) = number of respondents reporting the use of species divided by the total number of respondents (N).

$0 < RFC < 1$

Fidelity Level (FL)

Fidelity level is the percentage of respondents who cited the uses of specific plant species to treat a specific disease in the research area.

FL (%) = (Np/N) × 100 (Idmhand *et al*., 2020).

Where,
'Np'= Number of citations of specific species for a particular ailment
'N'= is the total number of informants who mentioned the species for any disease

Phytochemical Screening of Plants Used Against COVID-19

The identified plants were ranked and the top eight plants most frequently cited were qualitatively screened for alkaloids, flavonoids, cardiac glycosides, phenols, saponins, steroids, tannins, and terpenoids. The screening was based on the fact that active components effective against COVID-19 symptoms (fever, dry cough, fatigue, respiratory distress, aches and pains, sore throat, diarrhea, red itchy eyes, loss of taste and smell, skin rash, discoloration of fingers or toes, acute cardiac injury, catarrh, sneezing, headache) are reported to belong to these range of secondary metabolites (van Doremalen *et al*, 2020; Chia *et al*, 2020; Guo *et al.*, 2020; Ndam *et al*., 2014). Each of the plants was extracted in the following solvents: hexane, methanol, methylene chloride, and water, following standard procedures (Saio and Syiem, 2015). The solvents for extraction (Hexane, methylene chloride, and methanol) were recovered under reduced pressure through a rotary evaporator (BUCHI Rotavapor R-200) at the appropriate temperature, while the water extract was concentrated by drying through the oven at 40^{o}C. Residual solvent was removed by drying in air at room temperature (23-25 ^{o} C). The extracts were stored at -20 ^{o} C until used. An aliquot of each was used for phytochemical screening as reported by Sabri *et al.* (2012) and Ndam *et al*.(2014).

RESULTS

Socio-Demographic characteristics of respondents

The characteristics of the different respondents are presented in Table 1. 51% of the respondents were female while 49% were male. In terms of age 59% were between 20-40 years old, 34.7% between 41-60 years, and 6.3% were above 61 years. Level of education revealed that 34.3% did primary education, 42.3% did secondary education, 17.7% went to university while 5.0% had no formal education and 0.7% did other formations.

The demographic characteristics varied with the study sites (Table 2). The highest number of youths was recorded in Limbe (69) and the smallest in Tiko (21). The trend was not the same for adults where Buea had the highest number (39) and Mutengene had the least (12). Buea equally recorded the highest number of the elderly (7) while Limbe had the least (3). Considering gender, Buea had the highest number of males (48) while Mutengene had the highest number of female respondents (60). The least in males was Mutengene (26) while that for females was Tiko (24). Level of education equally showed variations from site to site although the respondents generally had a high level of formal education with all the sites recording values greater than or equal to 35 for the primary level except Tiko (7). The trend was the same for the secondary level of education, with all values for the different sites greater than or equal to 40 except in Tiko (22). However, at the University level, Mutengene had the highest number (25) while Buea and Limbe had the least (13 each).

Table 1: Demographic information of respondents to plants used against COVID-19 in Fako, Cameroon

Demographic Parameters		Description	Total Respondents (N=300)	Percentage (%)
Age	Youth	20-40	177	59.0
	Adult	41-60	104	34.7
	Elderly	>61	19	6.3
Gender		Male	147	49.0
		Female	153	51.0
Education		Primary	104	34.6
		Secondary	126	42.0
		University	56	18.6
		No formal education	12	4.0
		Others	2	0.7

Table 2: Demographic details of various study sites

Demographic Parameter		Description	Frequency				Percentage (%)			
			100	100	50	50				
			B	L	M	T	B	L	M	T
Age	Youth	20-40	54	69	33	21	54.4	69.0	66.0	42.0
	Adult	41-60	39	28	12	25	39.0	28.0	24.0	50.0
	Elderly	>61	7	3	5	4	7.0	3.0	10.0	8.0
Gender		Male	48	48	40	26	33	48.0	40.0	52.0
		Female	52	52	60	24	17	52.0	40.0	48.0
Education		Primary	37	37	35	7	25	37.0	35.0	14.0
		Secondary	43	43	40	22	21	43.0	40.0	44.0
		University	13	13	25	15	3	13.0	25.0	30.0
		No formal education	5	5	0	6	1	5.0	0.0	12.0
		Others	2	2	0	0	0	2.0	0.0	0

* B; Buea, L; Limbe, M; Mutengene, T; Tiko.

Ethnobotany of plants Used against COVID-19 in Fako

A total of 43 plant species (Table 3) were recorded belonging to 28 families and 38 genera. Asteraceae and Rutaceae were the most commonly used with 4 species each, followed by Zingiberaceae, Myrtaceae, and Lamiaceae having 3 species each, and Poaceae, Orobanchaceae, and Amaryllidaceae had 2 species each. The rest of the families had 1 species represented. The most used genus was *Citrus* with 4 species followed by *Ocimum* and *Allium* with 2 species each. The rest of the genera had 1 species. The 10 most used plants were *Cymbopogon citratus* (DC) Stapf with 100 citations, *Curcuma longa* L. with 83 citations, *Ocimum gratissimum* L. with 63 citations, *Allium sativum* L. with 61 citations, *Zingiber officinale* Roscoe with 58 citations, *Citrus limon* (L.) Osbeck with 53 citations, *Citrus aurantiifolia* (Christm.) Swingle with 47 citations, *Moringa oleifera* Lam. with 43 citations, *Ageratum conyzoides* L. with 37 citations, and *Allium cepa* L with 33 citations.

These plants varied with the different study sites. There were 37 species recorded in Buea, represented in 23 families and 29 genera, *Cymbopogon citratus* been the most frequently cited species (44), and Citrus, is the most used genus. Asteraceae was the most used plant family. Limbe registered 31 plant species, represented in 17 families and 27 genera with *Cymbopogon citratus* having the highest frequency of citation (33). Asteraceae dominated with 4 citation and *Citrus* was the most cited genus. Mutengene had 25 plant species, represented in 11 families and 19 genera with *Cymbopogon citratus* being the most cited species. Asteraceae dominated with 3 citation and Citrus was the most cited genus (3). Tiko recorded 34 plant species, represented in 20 families and 30 genera. The most used plant species was *Cymbopogon citratus* (6). Asteraceae (4) was the most used family and *Citrus* (3) was the most cited genus.

Table 4, shows some ethnobotanical indices that were assessed from the information gotten from the questionnaires. The species with the highest relative frequency of citations was *Cymbopogon citratus* with 0.333 followed by *Curcuma longa* with 0.277 and *Ocimum gratissimum* with 0.210 while the least cited were *Cynodon dactylon, Musa paradisiaca, Daucus carota*, and *Cocos nucifera* all with 0.003 each.
For the Use Value, the top species was *Curcuma longa* with 0.060, *Artemisia vulgaris* with 0.050 and *Allium sativum* with 0.043. Species with low use values were *Cynodon dactylon, Musa paradisiaca, Daucus carota*, and *Cocos nucifera* all with 0.000.
A high-Fidelity Level value (88.23%) was gotten from *Artemisia vulgaris*, followed by *Vernonia amygdalina* with 80.00% and *Eucalyptus globulus* at 83.33%. Those with low fidelity level values were *Cynodon dactylon,* and *Daucus carota* with 0.00 each Number of informants who cited the plant species.
The relationship between the relative frequency of citation and the use value was significant at 0.01 with an R-value of 0.950 (Table 5), indicating an association between the frequency of citation and use value.

Plant parts, Plant habits, and Plant based recipes
From the 43 plant species recorded, the proportions of plant parts and plant habits used in all four study sites are shown in Figures 2 and 3. The most used plant part was the leaf with 60.2% and the least used plant part was the stem with 0.1%.
A total of 22 plants-based recipes were recorded in which recipes 22, 7, and 9 (decoction) had the highest frequency of citations 26, 42, and 78 respectively, and the highest relative frequency of citations 8.66, 14.00, and 26.00 accordingly. The lowest plant-based recipe was 1 (chewing) with a frequency of citation of 2 and a relative frequency of citation of 0.65. The most used route of administration was the oral (Table 6). These plant-based recipes varied with the different study sites. Buea recorded the highest number of recipes (10), followed by Limbe (6), Mutengene (3), and Tiko (3). Recipe 7 (FC: 42, RFC: 14.00) was the most cited plant-based recipe in the four study sites while recipe 1 (FC: 2, RFC: 0.65) was the least cited.

Table 3: Plants used against Covid-19 in Fako Division

No	Family	Common name	Scientific name	Habit	Part used	Sites FC								Total FC
						Habits				Part used				
						B	L	M	T	B	L	M	T	
1	Amaryllidaceae	Onion	*Allium cepa* L.	Herb	Bulb	1	1	1	1	32	14	10	5	61
		Garlic	*Allium sativum* L.	Herb	Bulb	1	1	1	1	8	17	5	3	33
2	Anacardiaceae	Mango	*Mangifera indica* L.	Tree	Leaf	1	1	1	1	10	3	5	3	21
3	Annonaceae	Sour sop	*Annona muricata* L.	Tree	Fruit	1	1	1	0	4	2	1	1	8
4	Apiaceae	Carrot	*Daucus carota* (Hoffm). Schubl	Herb	Fruit	1	0	0	0	1	0	0	0	1
5	Apocynaceae	Cheese wood	*Astonei bonei* De Wild	Tree	Bark	1	0	0	0	4	0	0	0	4
		Quinqueliba	*Picralima nitida* (Stapf) T. Durand & H. Durand	Tree	Fruit	1	1	1	1	3	4	4	3	14
6	Arecaceae	Coconut	*Cocos nucifera* L.	Tree	Fruit	1	0	0	1	1	0	0	0	1
7	Asphodelaceae	Aloe vera	*Aloe vera* (L.) Bum.f.	Herb	Whole plant	1	1	0	1	16	3	0	3	22
8	Asteraceae	Artemisia	*Artemisia annua* L.	Herb	Leaf	1	1	1	1	4	4	5	4	17
		Bitter leaf	*Vernonia amygdalina* Delile.	Herb	Leaf	1	1	0	1	3	1	0	1	5
		Black jack	*Bidens pilosa* L.	Herb	Leaf	1	1	1	1	7	6	4	3	20
		King grass	*Ageratum conyzoides* L.	Herb	Leaf	1	1	1	1	15	12	5	5	37
9	Bromeliaceae	Pinneapple	*Ananas comosus* (L.) Merr	Herb	Fruit	1	1	1	1	2	11	2	2	17
10	Burseraceae	Plum	*Dacryodes edulis* H.J.Lam	Tree	Leaf	1	1	1	0	3	1	1	1	6
11	Caricaceae	Pawpaw	*Carica papaya* L.	Tree	Leaf/Seed	1	1	1	1	7	6	5	2	20
12	Clusiaceae	Bitter kola	*Garcinia kola* Heckel	Tree	Fruit/Seed	1	1	1	1	2	6	3	1	12
13	Curcubitaceae	Okomobong	*Telfaira occidentalis* Hook.f.	Herb	Leaf	1	1	1	1	11	3	1	1	16
14	Euphorbiaceae	Milk tree	*Euphorbia tirucalli* L.	Tree	Bark	1	1	0	1	5	2	0	1	8
15	Fabaceae	Senna alata	*Senna alata* (L.) Roxb	Herb	Leaf	1	1	0	0	3	1	0	0	4
16	Lamiaceae	Basil leaf	*Ocimum basiculum* (L.)	Herb	Leaf	1	1	1	1	5	5	2	1	13
		Massepo	*Ocimum gratissimum* L.	Herb	Leaf	1	1	1	1	31	17	11	4	63
		Mint	*Mentha spicata* L.	Herb	Leaf	0	0	0	1	0	0	0	4	4
17	Lauraceae	Pear	*Persea americana* Mill.	Tree	Leaf/Seed	1	0	1	1	6	5	3	2	16
18	Meliaceae	Neem	*Azardirachta indica* A.Juss	Tree	Seed	0	0	0	1	1	0	0	3	4

19	Moringaceae	Moringa	*Moringa oleifera* Lam.	Tree	Leaf	1	1	1	1	12	18	7	6	43
20	Musaceae	Banana	*Musa paradisiaca* L.	Herb	Leaf/Inflorescence	1	0	0	0	1	0	0	0	1
21	Myrtaceae	Clove	*Syzygium oromaticum* (L.) Merr	Tree	Fruit	1	1	0	1	2	3	0	1	6
		Eucalyptus	*Eucalyptus globulus* Labill	Tree	Leaf	1	0	1	1	3	0	1	2	6
		Guava	*Psidium guajava* L.	Tree	Fruit	1	1	1	1	12	5	3	1	21
22	Orobanchaceae	Eye for fowl	*Euphrasia officinalis* L.	Herb	Leaf	1	1	0	1	3	6	0	1	10
23	Pedaliaceae	Sesame	*Sesamum indicum* L.	Herb	Seed	0	1	0	1	1	0	0	3	4
24	Piperaceae	Black pepper	*Piper nigrum* L.	Herb	Fruit/Seed	0	0	0	1	0	0	0	2	2
25	Poaceae	Bahama grass	*Cynodon dactylon* (L.) Pers	Herb	Leaf	1	0	0	0	1	0	0	0	1
		Fever grass	*Cymbopogon citratus* (DC.) Stapf	Herb	Leaf	1	1	1	1	44	33	16	7	100
26	Rutaceae	Lemon	*Citrus limon* (L.) Osbeck	Tree	Fruit	1	1	1	1	29	17	5	2	53
		Lime	*Citrus aurantiifolia* (Christm) Swingle	Tree	Fruit	1	1	1	1	12	19	12	4	47
		Orange	*Citrus sinensis* (L.) Osbeck	Tree	Fruit	1	1	0	0	4	4	0	0	8
		Tangerine	*Citrus tangerine* Tanaka	Tree	Fruit	1	0	1	1	2	0	1	1	4
27	Viticaceae	Grape	*Vitis vinifera* L.	Tree	Fruit	0	0	0	1	1	0	0	3	4
28	Zingiberaceae	Alligator pepper	*Afromomum melegueta* (K. Schum)	Herb	Seed/Fruit	0	1	0	0	0	6	0	0	6
		Ginger	*Zingiber officinale* Roscoe	Shrub	Rhizome	1	1	1	1	43	8	6	1	58
		Tumeric	*Curcuma longa* L.	Shrub	Rhizome	1	1	1	1	36	28	12	7	83

* FC; Frequency of Citation, B; Buea, L; Limbe, T; Tiko, M; Mutengene

Table 4: Quantitative Ethnobotanical Information of plants used against Covid-19 in Fako Division

No	Common Name	Scientific Name	No of uses recorded per plant species	NIPS	RFC	UV	FL
1.	Alligator pepper	*Aframomum melegueta* (K. Schum)	3	6	0.02	0.01	50.00
2.	Aloe vera	*Aloe vera* (L.) Bum.f.	11	22	0.07	0.03	50.00
3.	Artemisia	*Artemisia vulgaris* L.	15	17	0.05	0.05	88.23
4.	Bahama grass	*Cynodon dactylon* (L.) Pers	0	1	0.00	0.00	00.00
5.	Banana	*Musa paradisiaca* (L.)	0	1	0.00	0.00	00.00
6.	Basil leaf	*Ocimum basilicum* (L.)	1	13	0.04	0.00	7.69
7.	Bitter leaf	*Vernonia amygdalina* Delile.	4	5	0.01	0.01	80.00
8.	Bitter kola	*Garcinia kola* Heckel	8	12	0.04	0.02	66.67
9.	Black jack	*Bidens pilosa L.*	2	20	0.06	0.00	10.00
10.	Black pepper	*Piper nigrum L.*	1	2	0.00	0.00	50.00
11.	Carot	*Daucus carota* (Hoffm.) Schubl	0	1	0.00	0.00	00.00
12.	Cheese wood	*Astonei bonei* De Wild	2	4	0.01	0.00	50.00
13.	Clove	*Syzygium oromaticum* (L.) Merr	4	6	0.02	0.01	66.67
14.	Coconut	*Cocos nucifera* L.	0	1	0.00	0.00	00.00
15.	Eucalyptus	*Eucalyptus globulus* Labill	5	6	0.02	0.01	83.33
16.	Eye for fowl	*Euphrasia officinalis* L.	2	10	0.03	0.00	20.00
17.	Fever grass	*Cymbopogon citratus* (DC.) Stapf	12	100	0.33	0.04	12.00
18.	Garlic	*Allium sativum* L.	13	33	0.11	0.04	39.39
19.	Ginger	*Zingiber officinale* Roscoe	7	58	0.19	0.02	12.06
20.	Grape	*Vitis vinifera* L.	1	4	0.01	0.01	25.00
21.	Guava	*Psidium guajava* L.	8	21	0.07	0.02	38.09
22.	King grass	*Ageratum conyzoides* L.	5	37	0.12	0.01	13.51
23.	Lemon	*Citrus limon* (L.) Osbeck	10	53	0.17	0.03	18.86
24.	Lime	*Citrus aurantiifolia* (Christm) Swingle	13	47	0.15	0.04	27.65
25.	Mango	*Mangifera indica* L.	4	21	0.07	0.01	19.04
26.	Massepo	*Ocimum gratissimum* L.	1	63	0.21	0.00	1.58

No	Common Name	Scientific Name	No of uses recorded per plant species	NIPS	RFC	UV	FL
27.	Milk tree	*Euphorbia tirucalli* Linn.	3	8	0.02	0.01	37.50
28.	Mint	*Mentha spicata* L.	1	4	0.01	0.01	25.00
29.	Moringa	*Moringa oleifera* Lam.	13	43	0.14	0.04	30.23
30.	Neem	*Azardirachta indica* A. Juss	2	4	0.01	0.00	50.00
31.	Okomobong	*Telfairia occidentalis* Hook.f.	5	16	0.05	0.01	31.25
32.	Onion	*Allium cepa* L.	10	61	0.20	0.03	16.39
33.	Orange	*Citrus sinensis* (L.) Osbeck	2	8	0.02	0.00	25.00
34.	Pear	*Persea Americana* Mill.	1	16	0.05	0.00	6.25
35.	Pawpaw	*Carica papaya* L.	9	20	0.06	0.03	45.00
36.	Pineapple	*Ananas comosus* (L.) Merr	4	17	0.05	0.01	23.52
37.	Plum	*Dacryodes edulis* H.J.Lam	1	6	0.02	0.00	16.67
38.	Quinqueliba	*Picralima nitida* (Stapf) T. Durand & H. Durand	8	14	0.04	0.02	57.14
39.	Sesame	*Sesamum indicum* L.	2	4	0.01	0.00	50.00
40.	Ringworm brush	*Senna alata* (L.) Roxb	3	4	0.01	0.01	75.00
41.	Sour sop	*Annona muricata* L.	2	8	0.02	0.00	25.00
42.	Tangerine	*Citrus tangerine* Tanaka	3	4	0.01	0.01	75.00
43.	Tumeric	*Curcuma longa* L.	18	83	0.27	0.06	21.68

*RFC: Relative Frequency of Citation, UV: Use Value, FL: Fidelity Level, NIPS:

Table 5: Correlation between RFC and UV

Correlations

		RFC	UV
RFC	Pearson Correlation	1	.950**
	Sig. (2-tailed)		.000
	N	43	43
UV	Pearson Correlation	.950**	1
	Sig. (2-tailed)	.000	
	N	43	43

**. Correlation is significant at the 0.01 level (2-tailed).

R= 0.950 (Positively significant

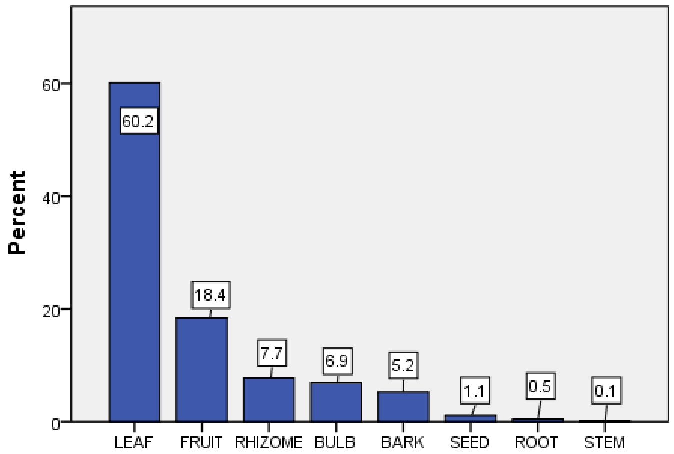

Figure 2: Plant part used in the prevention of COVID-19 in Fako division

The most used plant habits were herb with 45.6% and the lowest was shrub with 9.6% in all the sites.

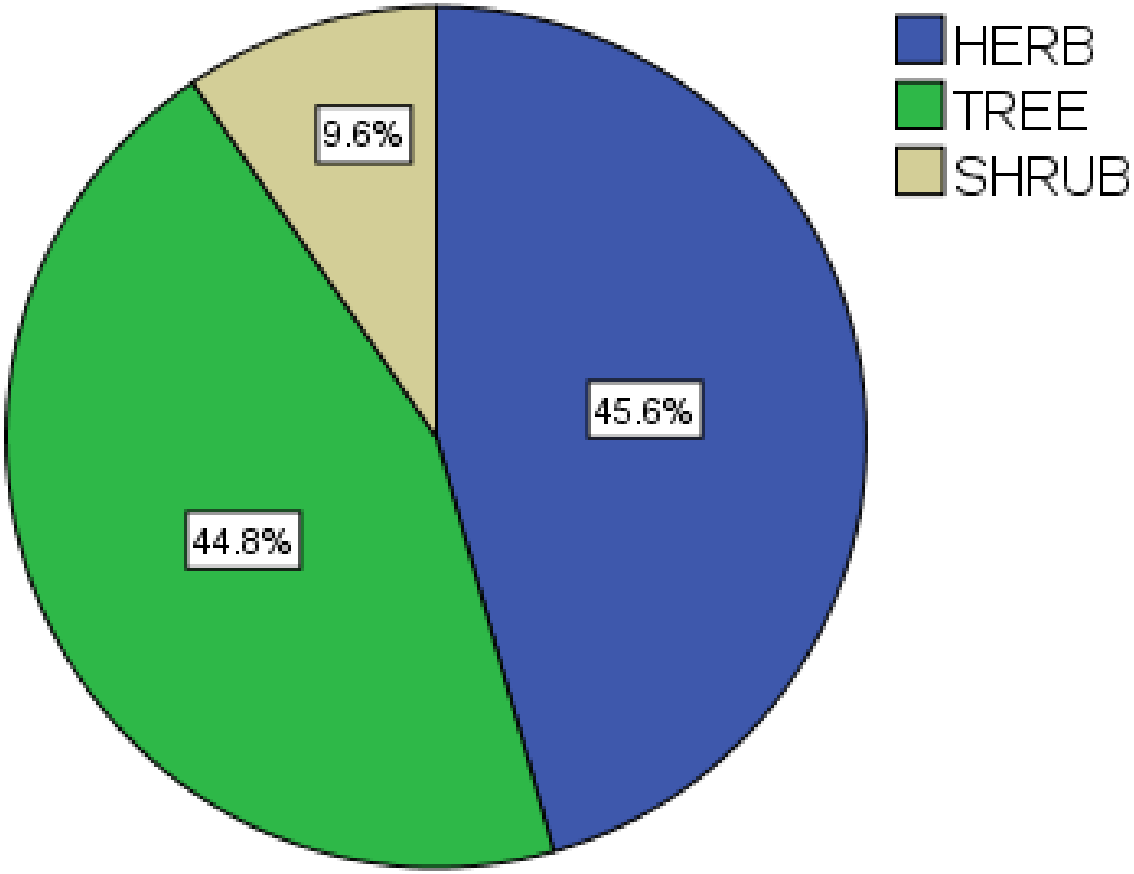

Figure 3: Habits of plants used against COVID-19 in Fako division

Table 6: Recorded recipes with their mode of preparation and route of administration.

Plant Based Recipes	Mode of preparation	Posology	FC	RFC (%)	Route of administration
RECIPE 1	The bulb of *Allium sativum* L is used by chewing.	Constant chewing	2	0.65	Oral
RECIPE 2	Infusion: Mix the juice of fruit of *Citrus aurantiifolia* (Christm.) Swingle with a tea spoon of honey in a glass of hot water.	Drink a glass a day.	4	1.33	Oral
RECIPE 3	Allow the bulb of *Allium sativum* L. in fresh water for 8hrs.	Drink a glass twice a day	4	1.33	Oral
RECIPE 4	Infusion: Bulb of *Allium sativum* L.and fruit of *Citrus aurantiifolia* (Christm.) Swingle are infused together.	Drink a glass twice a day	11	3.66	Oral
RECIPE 5	Infusion: Leaf of *Moringa oleifera* Lam. in hot water.	Drink a glass twice a day	5	1.66	Oral
RECIPE 6	Decoction: Leaf of *Carica papaya* L. is boiled in water.	Drink a glass twice a day or make a vapor bath every night before bed	5	1.66	Oral
RECIPE 7	Decoction: Rhizome of *Zingiber officinale* Roscoe, bulb of *Allium sativum* L., and the fruit of *Citrus aurantiifolia* (Christm.) Swingle are mixed and boil.	Drink a glass twice a day	42	14.00	Oral
RECIPE 8	Maceration: Macerate leaf of *Ageratum conyzoides* L. with fruit of *Citrus aurantiifolia* (Christm.) Swingle and olive oil in fresh water.	Drink a class twice a day.	4	1.33	Oral
RECIPE 9	Decoction: Fruit of *Combretum micranthum* G. Don are slice and put in fresh water, allow for some hours and shake.	Drink a glass thrice a day.	78	26.00	Oral

Plant Based Recipes	**Mode of preparation**	**Posology**	**FC**	**RFC (%)**	**Route of administration**
RECIPE 10	Decoction: Put Leaf of *Aloe vera* (L.) Bum.f. in fresh water. Allow for about 25minutes.	Drink a glass twice a day.	6	2.00	Oral
RECIPE 11	Decoction: Fruits of *Citrus aurantiifolia* (christm.) Swingle and rhizome of *Zingiber officinale* Roscoe are boiled in water.	Drink a glass twice a day.	8	2.66	Oral
RECIPE 12	Decoction: Fruit of *Citrus aurantiifolia* (christm.) Swingle and leaf of *Cymbopogon schoenanthus* (L.) Spreng are boiled in water.	Drink a glass twice a day and make a vapor bath every night before bed.	3	1.00	Oral
RECIPE 13	Decoction: Bulb of *Allium sativum* (L.) and fruits of *Ananas comosus* (L.) Merr and rhizome of *Zingiber officinale* Roscoe are boiled in water.	Drink a glass twice a day.	4	1.33	Oral
RECIPE 14	Decoction: Leaf of *Artemisia vulgaris* (L.) are boiled in water.	Drink a glass twice a day.	10	3.33	Oral
RECIPE 15	Decoction: Leaf of *Eucalyptus globulus* (Labill.) is boiled in water.	Dink a glass twice a day.	26	8.66	Oral
RECIPE 16	Maceration: Bulb of *Allium sativum* (L.); Bulb of *Allium cepa* (L.); Rhizome of *Curcuma longa* (L.) and rhizome of *Zingiber officinale* Roscoe. are macerated in water.	Drink a glass twice a day.	3	1.00	Oral
RECIPE 17	Decoction: Leaf of *Vernonia amygdalina* Delile. is boiled in water.	Drink a glass twice a day.	7	2.33	Oral
RECIPE 18	Deoction: Leaf of *Magnifera indica* (L.), Leaf of *Persea americana* (Mill.), Leaf of *Psidium guajava* (L.) and fruits of *Citrus aurantiifolia* (Christm) Swingle, are boiled in water.	Drink a glass once a day.	18	6.00	Oral

Plant Based Recipes	Mode of preparation	Posology	FC	RFC (%)	Route of administration
RECIPE 19	Decoction: Leaf of *Cymbopogon schoenanthus* (L.) Spreng and *Citrus limon* (L.) Osbeck in boiled water.	Drink a glass twice a day.	9	3.00	Oral
RECIPE 20	Decoction: Leaf of *Cymbopogon schoenanthus* (L.) spreng, Rhizome of *Zingiber officinale* Roscoe in boiled water and honey.	Drink a glass twice a day.	5	1.66	Oral
RECIPE 21	Decoction: Rhizome of *Curcuma longa* (L.) in warm water.	Drink a glass twice a day.	6	2.00	Oral
RECIPE 22	Decoction: Leaf of *Ocimum gratissimum* (L.) and Leaf of *Cymbopogon schoenanthus* (L.) Spreng in boiled water.	Drink a glass twice a day.	26	8.66	Oral

*RFC: Relative Frequency of Citation, FC: Frequency of Citation

Table 7. Phytochemical constituents of some Plants used against COVID-19 in Fako

Plants	Solvents	Phytochemical constituents						
		Steroids	Alkaloids	Cardiac glycosides	Phenolics	Tannins	Flavonoids	Saponins
Curcuma longa L.	Hexane	-	-	+++	-	-	++	++
	Methylene chloride	-	-	++	-	-	++	-
	Methanol	++	-	++	+	-	+++	+
	Water	-	-	+	++	-	++	+
Allium cepa L.	Hexane	+++	-	+++	-	-	++	-
	Methylene chloride	+	-	-	-	-	+	++
	Methanol	++	-	++	+	+	+++	+
	Water	-	-	-	++	-	-	++
Cymbopogon citratus (DC.) Stapf	Hexane	+++	-	+++	+	-	+	-
	Methylene chloride	++	-	-	-	-	-	+
	Methanol	++	-	+	-	-	++	+
	Water	-	+	+	+++	-	+	++
Ocimum gratissimum L.	Hexane	++	-	+++	+	++	-	-
	Methylene chloride	+++	-	-	-	-	-	-
	Methanol	+++	-	-	+	-	-	+
	Water	+	-	-	++	-	-	++
Allium sativum L.	Hexane	+	-	+++	-	-	+	-
	Methylene chloride	-	-	-	-	++	-	+

Plants	Solvents	Phytochemical constituents						
		Steroids	Alkaloids	Cardiac glycosides	Phenolics	Tannins	Flavonoids	Saponins
	Methanol	-	-	-	-	-	+	+
	Water	-	-	-	-	-	+	+
Moringa oleifera Lam.	Hexane	+++	-	+++	+	-	-	-
	Methylene chloride	+++	-	-	-	+	-	+
	Methanol	+++	-	-	+	-	-	+
	Water	+	+	+	+	-	+	+
Ageratum conyzoides L.	Hexane	+++	-	+++	+	+	++	-
	Methylene chloride	+++	-	-	-	+	-	+
	Methanol	+++	-	-	+	-	-	+
	Water	++	+	-	++	-	-	++
Zingiber officinale Roscoe	Hexane	+	-	+++	-	-	++	-
	Methylene chloride	-	+	-	-	-	+	-
	Methanol	+	-	-	-	+	++	+
	Water	+	+	-	+	-	-	+

Legend: +=Low concentration, ++ = Moderate concentration, +++ = High concentration, - = Absent

Phytochemical constituents of the eight most used plant samples in Fako Division.

From the 43 plant species recorded the eight with the highest frequency of citation were screened. A total of 102 active compounds were detected in different proportions and classes (Table 7). The extraction efficiencies varied with the different solvents used. When hexane was used as a solvent the plant's extracts showed that Steroids were found in seven plants with *Allium cepa, Cymbopogon citratus, Moringa oleifera and Ageratum conyzoides* extracts being very rich in these compounds while cardiac glycosides were found in all the eight plants, with all of them being very rich in these compounds.

Flavonoids were found in most of the plant extracts, except for those obtained from *Ocimum gratissimum* and *Moringa oleifera.* Phenols and Tannins were respectively found in four and two plant extracts with *Ocimum gratissimum* harboring the highest content of Tannins. Alkaloids were found in none of the plant extracts while saponins were found in one extract (*Curcuma longa).*

When methylene chloride was used as solvent steroids and saponins had the highest detection in five plants extracts, with the highest contents of steroids found in *Ocimum gratissimum, Moringa oleifera, and Ageratum conyzoides* while *Allium cepa* had moderate contents of saponins. Tannins and Flavonoids were present in three plant extracts each, with *Allium sativum* being moderately rich in tannins, while *Curcuma longa* had the highest content of flavonoids, and the other plant extracts did not contain these compounds. Only one plant extract had the presence of alkaloids (*Zingiber officinale*) and cardiac glycosides (*Curcuma longa).* Phenol was not found in any of the eight plant extracts.

When methanol was used as solvent steroids were found in seven plants extracts while saponins were found in all eight and they were highly expressed in the analyzed extracts of *Ocimum gratissimum, Moringa oleifera and Ageratum conyzoides*. Phenols and flavonoids were both present in four and five plant extracts each with *Curcuma longa and Allium cepa* being very rich in flavonoids. *Curcuma longa and Allium cepa* were found to be moderately rich in cardiac glycosides and absent in other plant extracts. Tannins were only found in *Zingiber officinale* and *Allium cepa* while alkaloids were absent in all eight plants extracts.

For the aqueous extract (water) it was found that tannins were absent while saponins were present in all the eight plant extracts with *Alliun cepa, Cybopogon citratus, Ocimum grattissimum*, and *Ageratum conyzoides* been moderately rich in these compounds. Flavonoids and cardiac glycosides were present in three extracts (*Curcuma longa*, *Cymbopogon citratus* and *Moringa oleifera*), phenols were found in seven of them with *Cymbopogon citratus* been very rich in these compounds. Steroids and alkaloids were present in four plant extract, with *Ageratum conyzoides* being moderately rich in steroids.

From the results, the plant extracts containing the highest number of active compounds were *Cymbopogon citratus* (15), *Curcuma longa, Allium cepa, Moringa oleifera,* and

Ageratum conyzoides (14). *Allium sativum* registered the lowest presence of these phytochemicals.

DISCUSSION

During this study, more females reported the use of plants against COVID-19 than males probably because women are more involved in the upbringing of children, homemakers, and health which equip them with varied strategies to care for their families (Villena-Tejada *et al*., 2021). This observation was the same for the four study sites except Tiko which recorded more males (26) than females (24). This may be because Tiko has many camps for CDC (Cameroon Development Cooperation) workers in which males are the main workers due to the high physical efforts demanded.

Interestingly, the youths (age groups below 40) reported using more plants than adults (41-60) and elderly (> 61), probably because since there exist no real drugs against COVID-19 they turn to alternative modes of treatment, coupled with the fact that their living within the family setting exposes them to gain knowledge of the use of plants from the elders as well as awareness and interest in the use of medicinal plants (Tiwari *et al*., 2020). However, in Tiko, adults recorded a higher number (25) compare to youths (21) because most adults are involved in the CDC work.

The study recorded a total of 43 plant species, belonging to 29 families and 38 genera. This was different from the results obtained by Chaachouay *et al*. (2021) who recorded 20 species belonging to 20 genera and 14 families in herbal markets of Sale Prefecture, North Western Morocco with *Azadirachta indica* A. Juss being amongst the list of the reported plants. Similarly, Cordoba- Tovar *et al*. (2022) documented 37 species in 32 genera and 22 families in western Columbia, with Lamiaceae and Verbenaceae being the most used families as opposed to Asteraceae and Rutaceae recorded in the current study. The taxa variation is an indication of how ethnobotanical/ethnomedicinal perception and knowledge vary from place to place. A study in Morocco recorded a total of 23 species including some similar species such as *Allium sativum, Allium cepa, and Zingiber officinale* (El Alami *et al*, 2020) while in Nepal, 60 plants belonging to 36 families were recorded (Khadka *et al*., 2021) for prevention of COVID-19.

The most used plant habit was herb due to their abundance while leaves were the most used parts of the plants corroborating the findings of other related studies (Amjad *et al,* 2017; Ahmad *et al,* 2021; Chaachouay *et al*. 2021; Khadka *et al*., 2021). The use of leaves is mainly due to the presence of active secondary metabolites as compared to other parts and also for their regenerative ability (Ghorbani *et al*, 2005) indicating that their utilization may not severely affect the sustainability of the resource base.

The most cited species in this study were *Cymbopogon citratus*, *Curcuma longa,* and *Ocimum gratissimum* L. Base on UV, the five most commonly used plants species were *Curcuma longa* (0.060), *Artemisia annua* (0.050), *Allium sativum* (0.043), *Moringa oleifera* (0.043) and *Citrus aurantiifolia* (0.043). Other studies had similar observations and attributed the effectiveness of *C. citratus* to the analgesic and anti-inflammatory properties of the essential oils; *C longa* extracts and curcuminoids to antibacterial, antifungal and antiviral properties (Clement *et al*., 2015). Various *in vivo* and *in vitro* studies have shown that *O. gratissimum* and its bioactive constituents possess pharmacological properties such as antioxidant, anti-inflammatory, anticancer, hepatoprotective, antidiabetic, antihypertensive, antidiarrhoeal, and antimicrobial properties (Ugbogu, *et al*., 2021). The species with the lowest UV were *Daucus carota, Cocos nucifera, Musa paradisiaca*, and *Cynodon dactylon* (0.00 each). They were used to treat vision and cardiovascular diseases. Low UV are not necessarily unimportant but indicates that traditional knowledge about them is at risk of not being transmitted and maybe gradually disappearing (Chaudhary *et al*., 2006). The value of UV was generally on the high side which emphasizes that the informants have a great rate of dispersal of knowledge about the species. The RFC index gives the authenticity of the frequency of citation of a species used for various ailments and other uses. The RFC of the reported plant species ranged from 0.003 to 0.333. RFC value varies from 0 (when nobody refers to a plant as a useful one), to 1 (with all the informants mentioning it as useful) (Tardio and Manuel, 2008). The species *Cymbopogon citratus, Curcuma longa, Ocimum gratissimum, Allium cepa* and *Zingiber officinale* having high RFC values indicated their abundant use and widespread knowledge among the respondents. The fidelity level of the 43 plant species ranged from 0.00% to 88.23%. In general, the high FL of a species indicates the prevalence of a specific disease (e.g Covid-19) in an area and the utilisation of the plant species by the inhabitants as alternative medicine. *Artemisia annua, Eucalyptus globulus, Vernonia amygdalina, Citrus tangerine*, and *Senna alatta* recorded 88.23%, 83.33%, 80.00%, 75.00%, and 75.00% respectively against Covid-19 in Fako, an indication of the high utility value attached to the species by the people of Fako Division, Cameroon.

For the 22 plants-based recipes registered, recipes 9, 7, and 22 had the highest RFC of citations which were 26.00, 14.00, and 8.667 respectively indicating that these preparation methods were highly used by the respondents as the species used for these recipes are common and usually consumed in various households.

A total of 102 compounds belonging to seven phytochemical groups were recorded from the 8 screened plant extracts. Similar compounds with potential anti-COVID-19 properties were reported when 149 plants from 71 families were screened (Bhuiyan *et al.*, 2020).

Results showed that different solvents resulted in various extraction yields as a result of differences in the polarity of the solvents. A higher extraction yield was observed in methanolic extract (29) followed by hexane extract (27) and water (27) compared to methylene chloride (18) indicating that the extraction efficiency favors the highly polar solvents as was observed in *Limophila aromatic* (Do *et al*., 2014). This can equally be attributed to the higher solubility of these compounds in methanol than the other solvents tested.

The studied bioactive compounds have a broad range of biological activities. For example, phytochemicals such as saponins have anti-inflammatory effects (Vinha and

Soares, 2012), hemolytic activity, and cholesterol-binding properties (Nyarko and Addy, 1990). Glycosides are known to lower blood pressure (Marinkovic and Vitale, 2008) and tannins exhibit antioxidant, antimicrobial and antiviral effects (Sayyah and Hadidi, 2004). The plant extracts were also revealed to contain steroids, which are known to produce an inhibitory effect on inflammation (Savithramma and Linga, 2011), and alkaloids that have been reported to exert analgesic, antispasmodic, and antibacterial activities (Nyarko and Addy, 1990). The phytochemical screening results of the extracts are consistent with the results reported by Alghazeer and El-Saltani (2012), where authors attributed the antioxidant activity of *Cynara scolymus* L. to the presence of tannins, alkaloids, saponin, and terpenoids. Chemical constituents 8-Gingerol and 10-Gingerol from *Z. officinale* were active against COVID-19 (Rajagopal *et al*, 2020). COVID-19 patients might have a cytokine storm (Bhaska *et al*, 2020; Mehta *et al*, 2020), and *Curcuma* species like *C. longa* can block cytokine release (Sordillo and Helson, 2015). *Allium sativum* contains proteins, and polyphenols like bioactive sulfur-containing compounds which are antiviral with immunostimulatory potential (Anywar *et al*, 2020; Sahoo *et al*, 2018). *Ocimum* species like *Ocimum gratissimum* extract contain Tulsinol (A, B, C, D, E, F, G) and dihydrodieuginol that possess immunomodulatory and Angiotensin- converting enzyme 2 (ACE II) blocking properties to inhibit replication of coronavirus (Varshney *et al,* 2020). *Mentha spicata* possess eugenol, terpenes, and flavonoids which are good antioxidants and modulators of xenobiotic enzymes which help to inhibit COVID-19 (Kong *et al*, 2020). *Euphorbia* species like *Euphorbia tirucalli* have antioxidant and antiviral activities (Lin *et al,* 2002). It has been documented that the quantity and the composition of bioactive compounds present in plants are influenced by the genotype, extraction procedure, geographic and climatic conditions, and the growth phase of the plants (Ciulei and Istodor, 1995; Trease and Evans, 2002). These results validate these claims and propose the exploitation of the studied species as potential sources for medication, characterized by the presence of bioactive compounds responsible for antimicrobial and antiviral activities, alongside other medicinal values.

CONCLUSION

The population of Fako used many different plants against COVID-19 which varied with sites. Herbs and leaves were the most used form and parts respectively. 102 active compounds were detected in different proportions and classes, from the eight screened plants suggesting their exploitation as potential sources for medication.

CONFLICT OF INTEREST

The authors do not declare any conflict of interest.

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